

In-Vivo Segmentation of the Human Nucleus Accumbens Using Diffusion Tensor Imaging and Probabilistic Tractography

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Introduction

- The nucleus accumbens plays a central role in reward processing and addiction. Therefore, DBS of the nucleus accumbens may be effective in the treatment of depression and addiction.
- The accumbens has been functionally and anatomically divided into core and shell subregions.
- Probabilistic tractography has been used previously to segment subcortical structures into functionally distinct regions.
- We now apply this technique to segment the nucleus accumbens *in vivo* in humans.

Methods

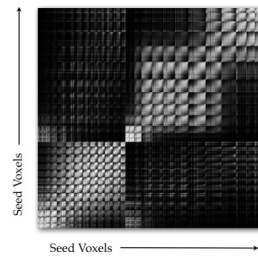
- T1-weighted MRI images were acquired in 7 healthy volunteers.
- 20-direction DTI was obtained.
- Seed masks for the nucleus accumbens were generated using FreeSurfer (<http://surfer.nmr.mgh.harvard.edu>).
- Probabilistic tractography and diffusion imaging were performed using FSL (<http://www.fmrib.ox.ac.uk/fsl>).
- The probability of connectivity between seed voxels and the whole brain was determined and subjected to k-means clustering analysis. We set the number of clusters to 2.

Nucleus Accumbens Seed Mask

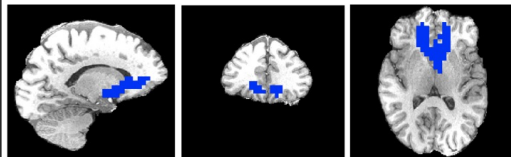


FreeSurfer Automated Parcellation of Nucleus Accumbens (orange areas)

K-Means Clustering

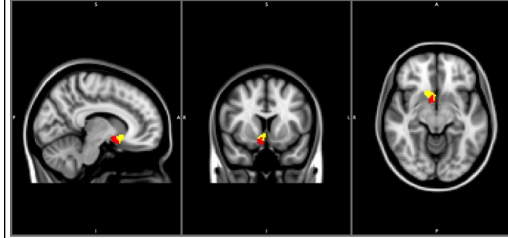


Nucleus Accumbens Connectivity



Representative subject with high level of connectivity with orbitofrontal cortex shown in blue.

Nucleus Accumbens Segmentation



Segmentation of the nucleus accumbens into 2 distinct regions averaged over subjects and displayed in MNI space.

Results

The nucleus accumbens was segmented into two distinct subregions using probabilistic tractography

These regions may reflect the underlying core vs. shell dichotomy of the nucleus accumbens.

Overall the nucleus accumbens showed strong connectivity with prefrontal and orbitofrontal cortex.

Conclusions

DTI-based tractography can be used to derive an *in-vivo* patient-specific connectivity map of the human nucleus accumbens.

This map may be used in the future for planning and refinement of DBS within the nucleus accumbens.

In addition, this technique provides allows us to noninvasively study the anatomy and connectivity the nucleus accumbens in humans for the first time.

The connectivity seen in this study may reflect the known dichotomy of the nucleus accumbens into core and shell subregions.

Selected References

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Learning Objectives

By the conclusion of this session, participants should be able to 1) Describe the importance of the nucleus accumbens in behavior 2) Describe the connectivity of the nucleus accumbens 3) Discuss the use of probabilistic tractography to study the connectivity of the nucleus accumbens.